



***Adapting Planar Solid Oxide Fuel  
Cells for use with Solid Fuel  
Sources in the Production of  
Distributed Power***

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# Objectives

## Program Objectives

- Quantify impacts of synthesis gas composition on performance of a commercial planar solid oxide fuel cell system (cell and stack)
  - $\text{H}_2\text{S}$  content
  - $\text{CO}/\text{H}_2$  ratio and energy content of gas
  - Particulate
  - Metal content
- Demonstrate long term operation of pSOFCs using actual sold fuel-derived synthesis gas
- Integrate CHP into distributed  $\text{H}_2$  production



# Project Approach

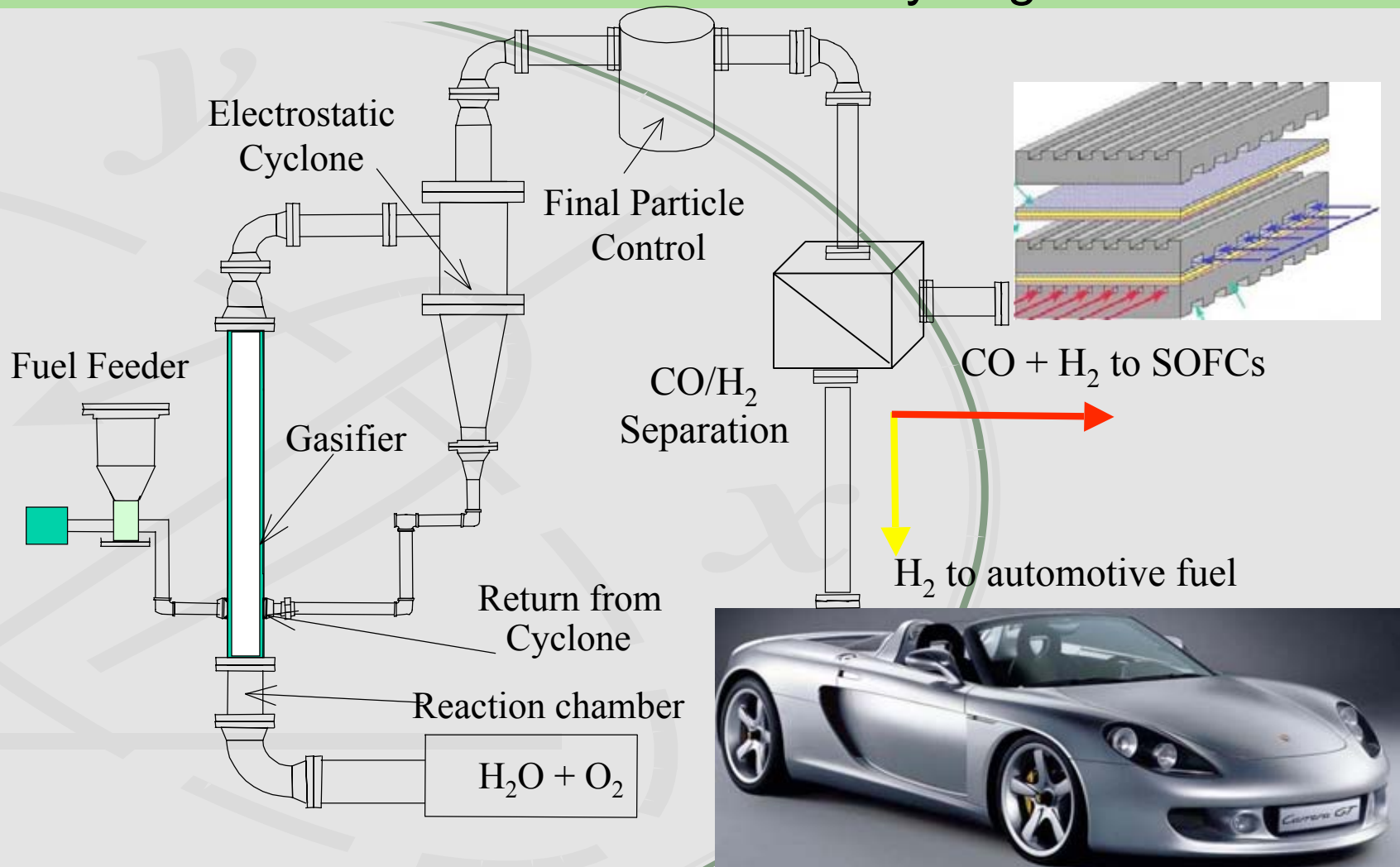
## Distributed CHP and Hydrogen

- Develop fuel cell CHP from solid fuels
- Test pSOFCs for tolerance to syngas contaminants using single cell and stack platforms
- Use of CO tolerant pSOFCs allow H<sub>2</sub>/CO separation without gas shift reactors
- Integrate CHP into distributed H<sub>2</sub> production



# Project Approach

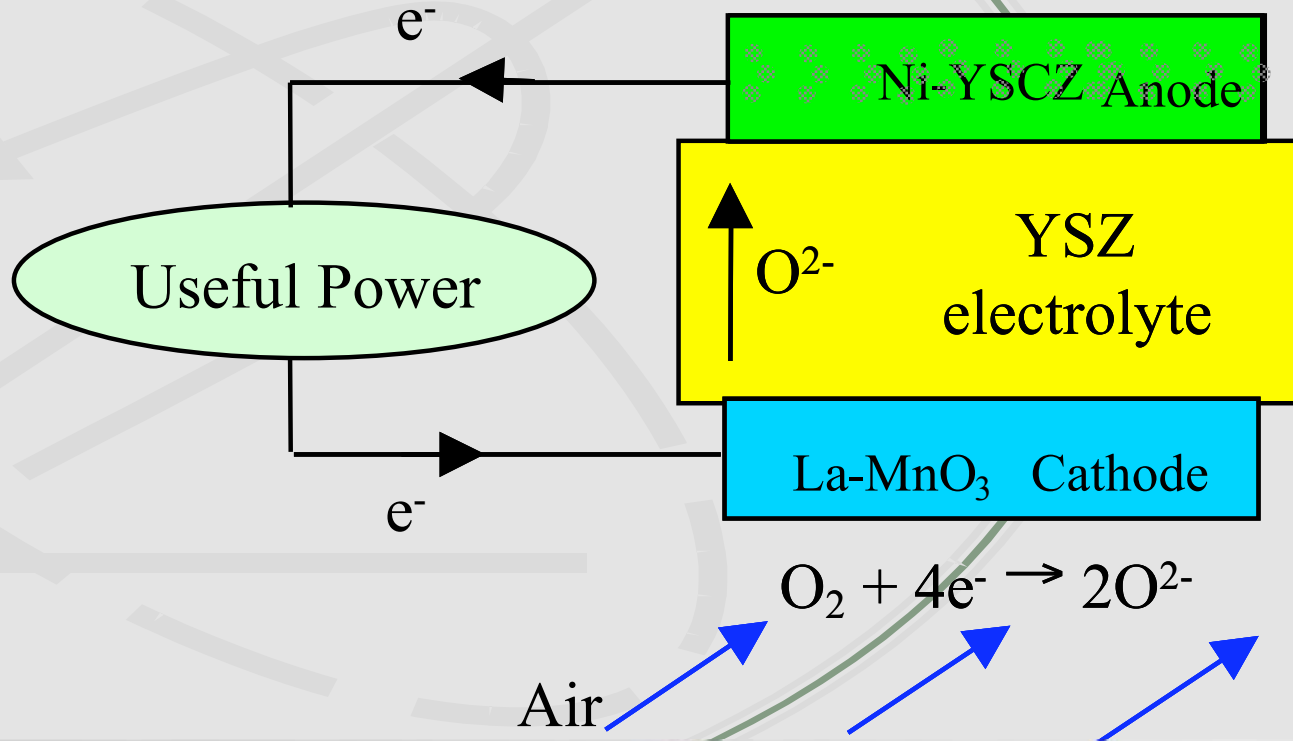
## Distributed CHP and Hydrogen



# Project Approach

## Solid Oxide Fuel Cells

Fuel: CO and H<sub>2</sub>



# Technical Barriers and Targets

## HFCIT Program Plan

- DOE Technical Barriers for Distributed Generation
  - Improved CO tolerance
  - Develop CHP fuel cell systems
  - Verify integrated stationary fuel cell systems
  - Mitigate technical barriers to stationary fuel cells
- DOE Technical Targets for 2010
  - 40,000 hours durability
  - \$1000/kWe

# Budget

## Budget and Expenditures

Category	Budget	Expenditures
Personnel	\$673,269	\$175,157
Fringe Benefits	\$140,579	\$37,029
Travel	\$16,500	\$6,523
Equipment	\$107,749	\$27,989
Supplies	\$84,483	\$61,058
Contractual	\$419,990	\$111,096
Construction	\$0	\$0
Other	\$263,165	\$84,483
Total Direct Charges	\$1,705,735	\$503,335
Indirect Charges	\$589,835	\$125,768
<b>Total</b>	<b>\$2,295,570</b>	<b>\$629,103</b>
DOE Share	\$1,926,744	\$505,133
Cost Share	\$368,826	\$123,970

# Project Safety

## Hydrogen, Carbon Monoxide and H<sub>2</sub>S Concerns

- FMEA Analysis
- Chemical hygiene training
- H<sub>2</sub>S training
- Gas containment and scrubber system
- Operational SOP's
- PSD's – gas monitors, SKAT packs, room monitors
- Verification gases to test monitors/detectors
- Notification and review with local authorities for the types and quantities of gases used



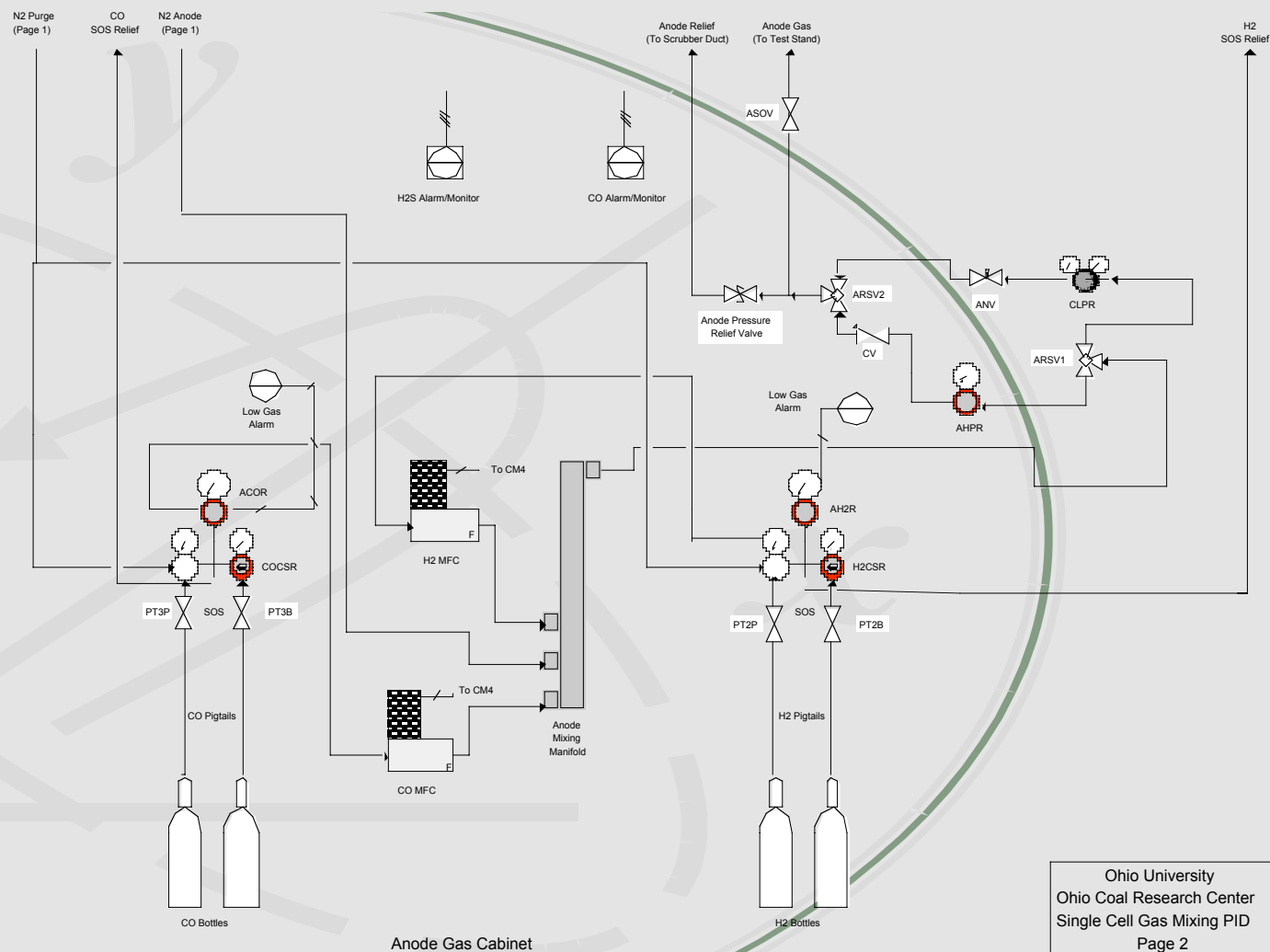


# Project Timeline

1. Modeling syngas/SOFC interface	Aug 03-Dec 04
2. Fabricate/install syngas system	Sep 03-May 04
3. Fabricate/install cell test stands	Sep 03-May 04
4. SOFC training for interns	Apr 04-Jun 04
5. SOFC material analysis baseline	May 04-Aug 04
6. Synthetic syngas testing	May 04-Dec 05
– 6.1 Baseline syngas	
– 6.2 Effect of Hg	
– 6.3 Effect of sulfur	
– 6.4 Effect of particulate	
– 6.5 Effect of energy content	
– 6.6 Effect of O <sub>2</sub> in oxidizer	
7. Electrostatic separation testing	Aug 04-Sep 06
8. H <sub>2</sub> :CO separation or shift	Aug 05-Aug 07
9. Integration of fuel cells/gasifier	Jan 06-Aug 07

# Project Accomplishments

## Gas Delivery (including H<sub>2</sub>S)



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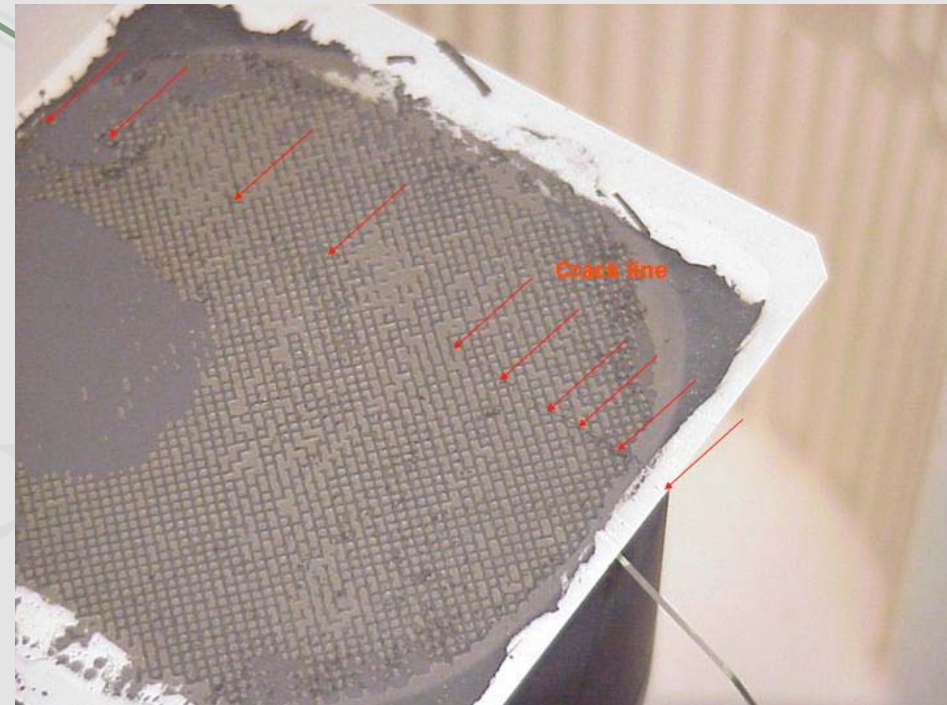
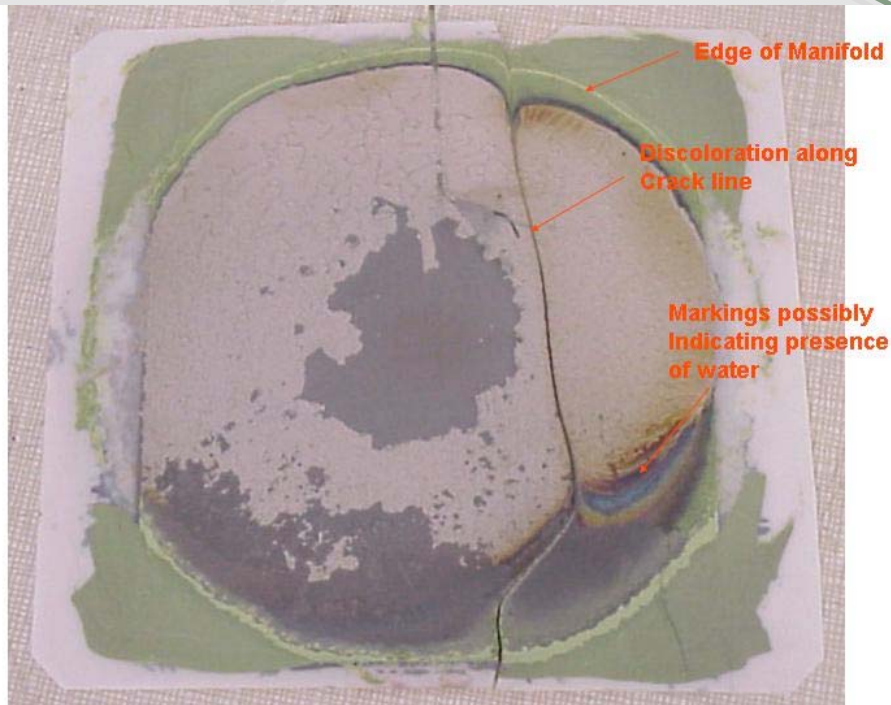
## Test Stands





# Project Accomplishments

## Fuel Cell



# Project Accomplishments

## Modeling

- Aspen platform
- Electrochemical model
- Thermal model
- Reforming/Gas Cleaning model
- Flow model



# Interactions and Collaborations

## Academic and Industrial Partnerships

- SOFCo-EFS (Fuel Cells)
- Case Western Reserve University
- University of Cincinnati
- State of Ohio's Air Quality Development Authority
- BAARD (Power Generation)
- Enercon (Gasification/Steam Reforming)

# Future Work

## Near and Long Term Plans

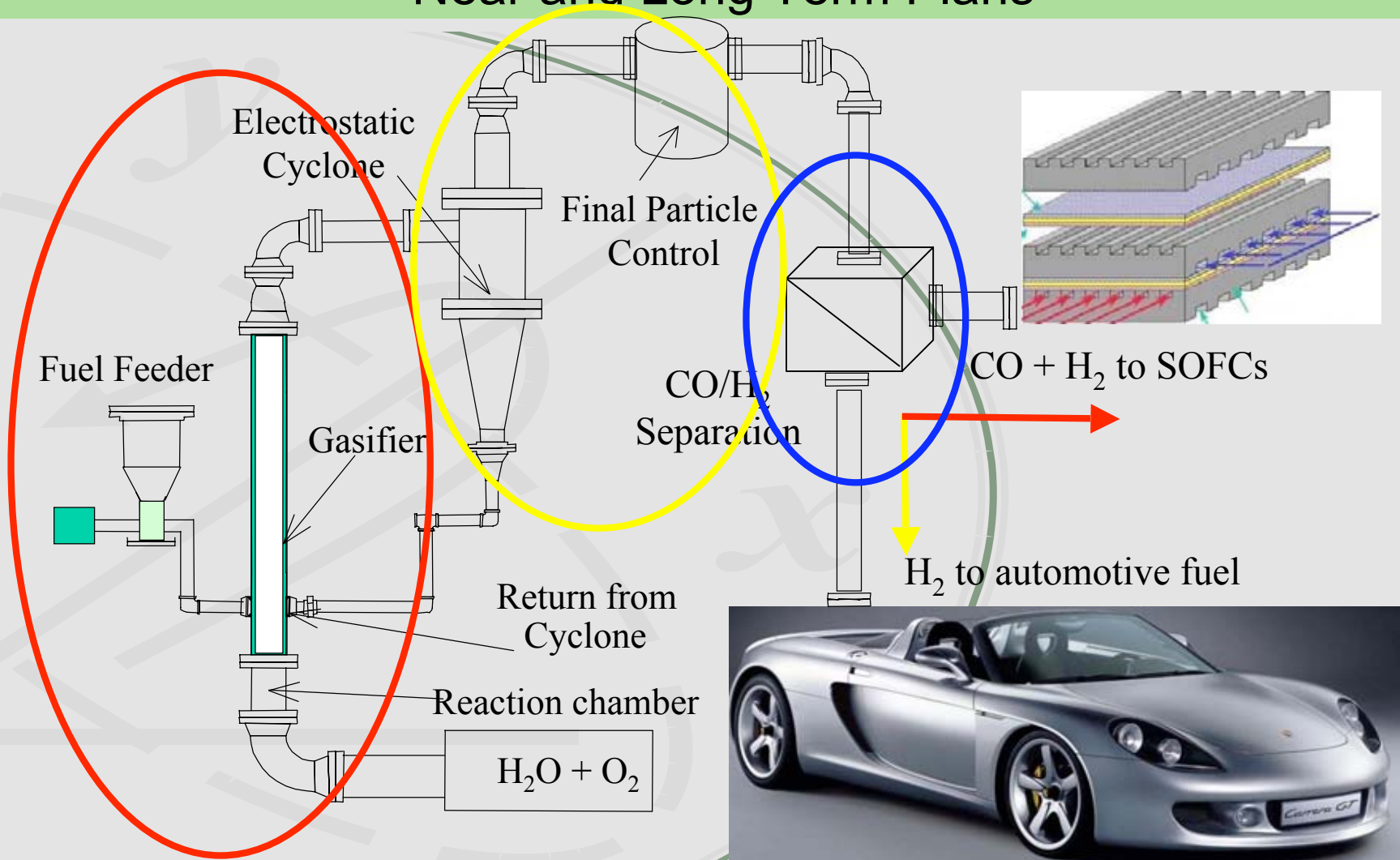
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# Future Work

## Near and Long Term Plans



# RUSS COLLEGE of Engineering and Technology



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